Nutrition Labeling: Does the Message Reach the Consumer?

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Food labeling has been the focus of major policy initiatives in the last few years. Some have argued that a particular benefit of health-related labeling of food is that it may effectively educate groups in the population not reachable by other approaches. The literature has highlighted the degree of variability within the population in health-related awareness, particularly in terms of education.[1] There is also some evidence that, at least for some diet-disease relationships, the presence of health-related marketing may decrease the gap in diet-disease awareness between individuals of different education levels (Ippolito and Mathios 1996). However, changes in diet-disease awareness does not necessarily translate into changes in food purchase behavior.

Several economic studies have examined the behavioral effects of providing health-related information to consumers (Brown and Schrader 1990, Putler 1987; Chang and Kinnucan 1991; Capps and Schmitz 1991; Zuo and Chern 1996; Spreen and Gao 1993; Ippolito and Mathios 1990, 96; Putler and Frazao 1991). However, these studies have focused on information provided by non-label sources (e.g., the news media). Levy et al (1985) and Levy and Stokes (1987) measured the market effects of a nutrition labeling program, but they did not examine whether the effects were different across consumers. Mathios (1996) examined the relationship between food choices and individual characteristics but was not able to isolate the effects of nutrition labeling.

[1] For a comprehensive review of this literature see Mathios (1996).

The empirical literature indicates that nutrition information provided at the point of purchase can affect market behavior, suggesting that changes in behavior are not solely driven by non-point of purchase sources. However, little research has been directed to determining whether point of purchase information has a differential effect on different socio-economic groups. This is potentially important since point-of-purchase information may reach more consumers. To bridge the existing gap in the literature we use market data to measure the effects of providing simplified nutrient information on consumer purchase behavior across different types of consumers.

Description of Data

The data are from a cooperative effort between Stop & Shop Supermarkets and the U.S. Food and Drug Administration to test the efficacy of nutrition shelf labeling (brand specific nutrition information provided on the shelf in conjunction with the products' unit and item price information). A total of 25 Stop & Shop Supermarket stores in Connecticut, Rhode Island, New Hampshire and Massachusetts were included within the experiment. Thirteen stores were designated as the treatment group and 12 stores were chosen as the control group. Socio-demographic data for individuals who shopped at the stores were provided by Stop &

Shop (the provided data were aggregated at the store level).[2] The stores span a broad range of neighborhood characteristics.

During 1985 both the treatment and control stores began using shelf tags to provide products' unit and item price information to consumers. From 1986 to 1989, the 13 stores in the treatment group implemented a nutrition education program. In the first year of the program (1986), treatment stores exhibited shelf tags augmented with nutrition information, distributed information booklets and displayed posters that provided nutrition information and an explanation of the shelf labeling program. In the second and third years of the program (1987-88), the treatment stores provided only nutritional shelf labeling. During the entire period, the 12 stores in the control group provided shelf labels that displayed only unit and item price information and did not include any special nutrition information. Monthly scanner-obtained sales, price and promotional data were collected at the product level for all participating stores during the entire time frame of the experiment.

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[2] The socio-demographic data are from proprietary data files collected by Stop & Shop as part of their market research. The data are collected by phone using a random-digit-

Methods

The demand model used here is based on an AIDS framework (Deaton and Muelbauer 1980) expanded to include information effects (Piggott et al. 1996) and demographic characteristics (Muelbauer and Pashards 1981). The expanded AIDS model begins with the household's expenditure function (e)

(1a) $\log [e(p, U, a(S; \chi), \Omega; \varphi)/k_h] = \Phi(p, a(S; \chi), \Omega; \varphi) + b(p)U$

where p denotes prices; U is some index of the household's utility; a(·) denotes an awareness function which is influenced by information, S, and a vector of individual characteristics that may affect information access costs, χ; Ω, denotes other demand influences (such as product taste or seasonality); φ denotes a vector of household demographic characteristics that may affect the relative weights given to health assessments versus other quality attributes; and k_h is a general measure of household size to deflate the budget of the household to a 'needs-corrected' per capita basis (Deaton and Muelbauer 1980).

Following the expanded AIDS model, we define the terms in (1a) for the h^{th}household, shopping in the m^{th} store in time period t as:

(1b) $\Phi(\mathbf{p}, \mathbf{a}(S; \chi), \Omega; \varphi) = \alpha_0 + \Sigma\alpha_{ihmt} \log P_{imt} + (1/2) \Sigma\Sigma\gamma_{ij} \log P_{imt} \log P_{jmt}$,

(1c) $\alpha_{ihmt} = \{\xi_i + \tau_i T_t + \phi_{1i} L_{mt} + \phi_{2i}(L_{mt} T_t) + \eta_{1i} E_h + \eta_{2i} (L_{mt} E_h)$

$+ \omega_{1i} A_h + \omega_{2i} (L_{mt} A_h) + \theta_{1i} S_t + \theta_{2i} W_t\}$,

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dial method and are screened for individuals who stated they shop at Stop & Shop food stores.

and

$$\text{(1d)} \qquad b(p) = \beta_0 \, \Pi \, P_{jt}^{\beta_j}$$

where subscripts i and j denote goods; T_t is a time trend; L_{mt} is a nutritional labeling indicator variable equal to one in treatment stores after the labeling program is implemented and zero otherwise; ($L_{mt}\, T_t$), a label-trend interaction term, is included to measure time-dependent nutritional labeling effects; E_h denotes the average number of years of education for the adult shopper in the household; ($L_{mt}\, E_h$), a label-education interaction term, is included to test whether there is any differential effect of the nutritional labeling across households with different levels of education; A_h denotes the average age of the adult shopper in the household; ($L_{mt}\, A_h$), a label-age interaction term, is included to measure any differential effect of the nutritional labeling across age. S_t and W_t represent seasonal indicator variables. S_t is equal to one in the summer months (June, July, and August) and zero otherwise; and W_t is equal to one during the winter months (December, January, and February) and zero otherwise; P_{jmt} is the price of good j sold in store m at time t.[3]

Taking the derivative of (1a) with respect to log P_{imt} and substituting for U_h provides a share equation for the i^{th} good during time t at the household level,

$$\begin{aligned}\text{(2)} \qquad W_{ihmt} = {} & \xi_i + \tau_i T_t + \phi_{1i} L_{mt} + \phi_{2i}(L_{mt}\, T_t) + \eta_{1i}\, E_h + \eta_{2i}\, (L_{mt}\, E_h) \\ & + \omega_{1i}\, A_h + \omega_{2i}\, (L_{mt}\, A_h) + \theta_{1i} S_t + \theta_{2i} W_t + \Sigma_j\, \gamma_{ij} \log P_{jmt} + \beta_i \log(Y_{ht} / k_h\, P^*_t)\end{aligned}$$

[3] Although gender and race have been found to influence nutrition label use, these variables are not included in the analysis because there is little variation in the gender variable across stores and the variation in the race variable is confounded with the experimental design.

where $W_{ihmt} = \{(P_{imt} X_{iht})/ Y_{ht}\}$ is the share of household income spent on good 'i', X_{jht} denotes the quantity of good j chosen by household h during time t, Y_h is total household income and log $P^* = \Phi(\bullet)$.

A benefit of the AIDS framework is that it fulfills the conditions required for exact non-linear aggregation; the share equations derived from the AIDS model can be seen as coming from a single representative household endowed with income Y and facing market prices. The aggregated equation is approximated by

$$(3) \quad W_{imt} = \xi_i + \tau_i T_t + \phi_{1i} L_{mt} + \phi_{2i}(L_{mt} T_t) + \eta_{1i} E_m + \eta_{2i} (L_{mt} E_m) + \omega_{1i} A_m + \omega_{2i} (L_{mt} A_m) + \theta_{1i} S_t + \theta_{2i} W_t + \Sigma_j \gamma_{ij} \log P_{jmt} + \beta_i \log(\boldsymbol{\Psi}_{mt}/P^*_t)$$

where log $\boldsymbol{\Psi}_{\mathbf{m}}$ is average household income divided by the average household size, $\mathbf{K}_{\mathbf{m}}$, included in the Stop & Shop data.

The general expression for each equation in the demand system is as (3) except that the prices for the goods of interest are now share-weighted prices[4], E_m and A_m are represented by their respective means, and the dependent variable for the equation representing all other goods is $\{\boldsymbol{\Upsilon}_{\mathbf{mt}} - \Sigma_j(P_{jmt} * X_{jmt})\}/ \boldsymbol{\Upsilon}_{\mathbf{mt}}$, where $\boldsymbol{\Upsilon}_{\mathbf{mt}}$ is equal to the calculated aggregate income for each store/time period. The non-linear system of equations is estimated using iterative seemingly unrelated regression with the adding-up,

[4] Following LaFrance (1992), the price of the commodity representing all other goods is normalized to one, eliminating this 'price' from the right hand side of the estimating equation (because log(1) = 0).

homogeneity and symmetry conditions imposed on the system.[5] Given the data are time-series, potential autocorrelation is corrected by following the procedures outlined by Berndt and Savin (1975) and Piggott et al (1996).

The analysis of the impact of the nutrition labeling program focuses on several categories of products that vary in terms of the size/composition of the choice set, and vary in terms of the nutrition information being provided. Each demand system is composed of three equations: one equation for the varieties of the good that in the treatment stores were labeled as “healthy”, one for the varieties that were not labeled in the treatment stores (which we will designate as “unhealthy” for convenience), and one equation for all other goods. Except for salad dressing (where multiple flavors are represented in each equation), the products represented by the ‘healthy’ and ‘unhealthy’ demand equations are relatively homogeneous across products within the category. Note that before implementation of the labeling program both ‘healthy’ and ‘unhealthy’ goods are unlabeled. ‘Healthy’ goods are labeled (unlabeled) in treatment (control) stores after implementation of the labeling program; ‘unhealthy’ goods are not labeled in either the treatment or control stores after implementation of the labeling program.

[5] All the models were estimated both with and without the restrictions imposed. Using the joint test procedure of Gallant (1987), we found no significant difference between the restricted and unrestricted models.

Results

Effects of the income, seasonal and price coefficients

With only one exception, all the significant income coefficients were negative, suggesting that the share of income devoted to purchases of these food categories decreases with increases in income, i.e., that these food items are not luxury goods. All significant own-price coefficients are also negative indicating that an increase in own-price leads to a decrease in share; all significant cross-price coefficients indicate 'healthy' and 'unhealthy' products are substitute goods. The coefficients on the seasonal variables indicate that milk share decreases (increases) during the summer (winter). Conversely, mayonnaise and salad dressing shares increase during the summer months. These results, while not central to our thesis, conform with prior expectations and lend credence to the estimation results.

Effects of the time, education and age coefficients

The time trend coefficients suggest that consumers were increasing their expenditures on milk, cream cheese, and refried beans and decreasing their expenditures on peanut butter and mayonnaise over time. The results also suggest that, even without the labeling program in place, they were moving their purchases from 'unhealthy' (high fat) milk to 'healthy' (low fat). However, the converse is true in the refried bean, mayonnaise and salad dressing markets.

Increases in education level appear to cause increased expenditure shares on 'healthy' milk, peanut butter and mayonnaise, but decreased expenditure shares on ‘healthy’ cream cheese, refried beans and salad dressing. Except for salad dressing, the older the shopper the greater the shares of ‘unhealthy’ products. There was no differential effect of age on the shares of ‘healthy’ and ‘unhealthy’ salad dressing.

Effects of nutritional labeling

Given the many cross-product terms, it is especially difficult to untangle from the results all the effects of labeling. In addition, it may be true that information is causing substitution between product classes. In any event we can draw some conclusions from the results. The effect of the label-related coefficients (label, label-education and label-age interaction terms) indicate that the presence of the labeling program increased ‘healthy’ milk, cream cheese, refried bean and peanut butter shares among all consumers. However, the labeling program *decreased* ‘healthy’ mayonnaise and salad dressing shares. Except for refried bean share (where there was no differential impact of the labeling program across households with different education levels), the impact of the labeling program is greatest among communities with less education. Although the impact of the labeling program reduces ‘healthy’ mayonnaise and salad dressing shares, the education effect is consistent with the effect seen with the other food categories; the market effect of the labeling program is greatest (most negative) among less educated households. Except for milk share (where there was no differential effect across age), label-induced changes where lower among older households.

Conclusions

The label-education interaction terms were consistent in their effects; they decreased the main effect of the label-dummy coefficients for more educated individuals. Where the label-dummy terms indicated that the label increased the share of ‘healthy’ products, this effect was greatest among less educated individuals; and where the label-dummy terms indicated that the label decreased the share of ‘healthy’ products, this effect was also greatest among less educated individuals. Interestingly, the size of the label-education effect varied across product/nutrient categories.

One explanation for these results is that more educated individuals may have relatively ‘better’ (more accurate) priors about food products, although the accuracy of these priors varies across product and nutrient categories. If this is the case, then the label information would have a lower market effect among more educated individuals and the cost of ignorance would be lower among these individuals. In essence, more educated individuals may have already made their food purchase adjustments before implementation of the labeling program.

The age coefficients consistently indicate that older individuals are more likely to purchase ‘unhealthy’ products. The label-age interaction terms are also consistent in dampening the main effect of the label-dummy coefficients for older individuals. Where the label-dummy terms indicate that the label increases the share of ‘healthy’ products, this effect is smallest for older individuals; where the label decreased the share of ‘healthy’ products, this effect is also smallest among older individuals. These effects seem consistent with results indicating that older individuals are less likely to be aware of diet-disease issues and are less likely to use health-related information.[6] These results may be due to older individuals facing higher information ‘costs’ (due to reduced cognitive and visual abilities). Alternatively, older individuals may see themselves as obtaining relatively little benefit from ‘healthy’ eating (due to a shorter expected future life).

[6] An alternative explanation is that older individuals may be less likely to trust nutrition label information. However, Derby (1995) indicates that older individuals find nutrition labels to be more credible.

Table 1: Parameter results

	'Healthy Products'	'Unhealthy'
Milk		
Intercept	0.00149551***	0.00431926***
$\log(\mathbf{\Psi}_{mt}/P^{*}_{t})$	-0.00005135	-0.00031339***
Time	3.512072E-6***	-1.81844E-6**
Label dummy	0.00097717***	0.00019495
Label * Time	8.096599E-6***	3.143424E-6*
Education	0.00022431***	0.000026413
Label * Education	-0.00008763***	-4.84313E-6
Age	-0.0000306***	0.000016134***
Label * Age	1.310175E-6	-0.00001026
Summer	-0.00001772*	-0.00003785**
Winter	0.000027674***	0.00005783***
Own Price	-0.00067253***	-0.00142292***
Cross Price	0.00104857***	0.00104857***
Cream Cheese		
Intercept	-0.00016155	-0.00104140***
$\log(\mathbf{\Psi}_{mt}/P^{*}_{t})$	-0.00002835**	0.000049103***
Time	2.079448E-6***	2.383709E-6***
Label dummy	0.00020976*	0.00064997***
Label * Time	-1.42723E-6***	-8.42554E-7**
Education	2.276292E-6	0.000022642***
Label * Education	-2.50027E-6	-0.00002554***
Age	-1.00436E-6	2.194424E-6**
Label * Age	-4.93605E-6*	-0.00001081***
Summer	-7.46995E-6*	6.759045E-6*
Winter	9.230628E-7	-6.19534E-6
Own Price	-0.00029665***	-0.00022318***
Cross Price	0.000033337	0.000033337
Refried Beans		
Intercept	0.000038772***	0.000095765***
$\log(\mathbf{\Psi}_{mt}/P^{*}_{t})$	-4.47834E-6***	-0.00001584***
Time	4.430726E-8***	1.102409E-7***
Label dummy	0.000037992***	0.00011964***
Label * Time	5.7282E-8**	5.110419E-8
Education	1.867662E-6***	4.308723E-6***
Label * Education	-4.95881E-8	2.840756E-7
Age	-5.23096E-7***	-1.76375E-7
Label * Age	-1.14459E-6***	-3.80405E-6***
Summer	1.303398E-7	1.179822E-6*
Winter	3.278641E-7	2.552361E-6***
Own Price	-1.28502E-6	8.066438E-7
Cross Price	2.365481E-6***	2.365481E-6***

Table 1 (Continued)

Peanut Butter		
Intercept	0.00051362***	0.00064271***
$\log(\boldsymbol{\Psi}_{\mathbf{m}t}/P^*_t)$	-0.00018624***	2.481357E-6
Time	-1.23548E-6***	-7.89806E-7***
Label dummy	0.00072042***	-0.00005873
Label * Time	-1.00849E-7	1.615042E-6***
Education	0.00007779***	-8.84583E-6*
Label * Education	-0.0000363***	0.000020751***
Age	3.687094E-6***	6.421512E-6***
Label * Age	-9.22779E-6***	-5.97764E-6***
Summer	-0.00001363***	5.974863E-7
Winter	8.66533E-7	4.939838E-6
Own Price	-0.00010986***	-2.3764E-7
Cross Price	0.000048551**	0.000048551**
Mayonnaise		
Intercept	0.00042***	0.000472**
$\log(\boldsymbol{\Psi}_{\mathbf{m}t}/P^*_t)$	-2.9E-05	-4E-05
Time	-3.1E-06***	-8.2E-07***
Label dummy	-0.0002*	2.84E-06**
Label * Time	2.8E-06***	5.56E-07***
Education	8.9E-06*	-3.1E-06
Label * Education	4.5E-06	3.31E-05***
Age	-2.9E-06**	5.05E-06**
Label * Age	2.84E-06	-1.4E-06***
Summer	0.00003***	2.6E-06***
Winter	-9E-06**	-2.1E-06
Own Price	-0.00023***	-0.00007
Cross Price	0.00015***	0.00015***
Salad Dressing		
Intercept	0.00019***	-0.00026**
$\log(\boldsymbol{\Psi}_{\mathbf{m}t}/P^*_t)$	9.00E-06	-5.6E-05***
Time	-7.00E-07***	3.10E-06***
Label dummy	-0.00045***	0.000653***
Label * Time	9.19E-07*	-2.37E-06***
Education	-1.40E-05***	4.53E-05***
Label * Education	1.40E-05***	-1.65E-05***
Age	6.00E-06***	6.02E-06***
Label * Age	7.00E-06***	-1.32E-05***
Summer	1.70E-05***	4.16E-05***
Winter	-3.00E-06	8.73E-06*
Own Price	-1.50E-04*	-1.10E-05
Cross Price	3.00E-05	3.00E-05

An * denotes significance at the 10 percent level, ** denotes significance at the five percent level and *** denotes significance at the one percent level.

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